54006.8012.US01 P02-0035US2 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF:	Ronald G. BREESE *et al.*	EXAMINER:	
APPLICATION NO.:	10/692,829	ART UNIT:	
FILED:	October 23, 2003	CONF. NO:	
FOR:	**APPARATUS AND METHODS FOR REMOVING METALLIC CONTAMINATION FROM WAFER CONTAINERS**		

DECLARATION OF INVENTOR CHARLES JAMES BRYER UNDER 37 CFR RULE 1.132

Commissioner for Patents

P.O. Box 1450

Alexandria, VA 22313-1450

Sir:

I, CHARLES JAMES BRYER, declare:

1. I am an Engineer at Semitool, Inc. Kalispell, Montana. Semitool, Inc. designs and manufactures cleaning equipment for the semiconductor manufacturing industry. I have worked as an engineer in this industry for several years. I am familiar with the technologies used in this industry. I am a joint inventor of U.S.

Patent No. 6,432,214 which relates to equipment for cleaning boxes or wafer containers used in the semiconductor manufacturing industry.

2. Before the July 19, 2002 filing date of our patent application, I and others at Semitool, Inc. determined that our customers (semiconductor device manufacturers) wanted a machine which could remove metal contamination from the boxes (such as FOUPs—front opening unified pods) used to store and move semiconductor wafers, and similar articles, in the "fab" or manufacturing facility. These boxes or containers are primarily plastic. They have slots or grooves at the sides, for supporting the edges of the wafers. In use, small amounts of metal from wafers rub, abrade, or shake off and deposit onto the grooves or slots. This causes the box to become contaminated with metal particles. Unless removed, these particles can contaminate the next batch of wafers placed into the box.

3. I began to research whether we could design a machine which could clean metal contamination from the boxes. It was well known at that time that metals could be removed from plastic surfaces using common acids, such as hydrochloric acid, sulfuric acid, nitric acid, or hydrofluoric acid. However, I realized that we could not use acids here, because the boxes also have metal components, such as screws and springs. Use of acids on the boxes over time would severely corrode and dissolve away the metal components. Consequently, if acids were used, the box would quickly become unusable. I therefore rejected use of acids and began to consider alternatives.

4. It was common practice at the time to use chelating agents in wet bench processing, to prevent metal particles from depositing on the wafers being processed. Wet benches use large tanks filled with processing liquids. Wafers are immersed into the bath of liquid, to perform a process step. Typically, the wafers are sequentially immersed in a series of baths, followed by a rinsing step. I considered whether this approach might be useful in solving the problem of cleaning metal contamination from boxes. Initially, I concluded that immersion processing of boxes was simply not practical, due to the size of the boxes. Wafers are typically round flat disks, 200 mm or 300 mm in diameter, and about 1 mm or less thick. Consequently, since they are flat, large numbers of wafers can be processed together in a batch, in a wet bench immersion process. Boxes, on the other hand, are typically designed to hold 25 wafers. As a result, a single box is a relatively bulky cube-like shape, roughly 350-400 mm on edge. This means that with immersion processing of boxes, very large tanks would be needed to process several boxes simultaneously. Alternatively, if smaller tanks were used, then only one or two boxes, for example, could be cleaned at a time. Due to these constraints, I rejected immersion processing.

5. Another problem with immersion processing, in connection with removing metals, is that the immersion bath itself could quickly become contaminated. Consequently the bath liquid may have to be frequently drained, discarded, and replaced with fresh liquid. This would be time consuming and costly. This was another reason for rejecting immersion processing.

6. Another reason that I rejected immersion processing is because, while chelating agents were known to prevent deposition of m tals onto immersed wafers, it was not clear as to whether chelating agents would remove metals already deposited onto a box. In addition, it was also unknown whether chelating agents could be used with boxes, because wafer surfaces typically are oxides, nitrides, metal films, or silicon, while boxes are plastic or polymers. Many of the cleaning chemistries commonly used on wafers, such as acids, are too harsh for use on boxes.

7. In my research on chelating agents, I contacted Aldrich Chemical Co., Milwaukee, WI, a manufacturer of chelating agents used in wet bench immersion processing. I discussed with them our concept of spraying chelating agent solution onto boxes, to remove metals. However, the representative of Aldrich Chemical Co., an Applications Engineer, stated that our concept would not work. The Applications Engineer explained that chelating agents "act like a glove" and wrap around metal molecules, to prevent the metal molecules in the bath of liquid from adhering or depositing onto the surfaces of the immersed wafer. Due to this "act like a glove" action, the Applications Engineer said that chelating agents would not be useful in actually removing metals from the boxes.

8. While this information from the Aldrich Chemical Co. Applications Engineer was highly discouraging, I proceeded to run tests anyway using chelating agents in the box cleaning spray machine as d scribed in the application. Simultaneously, I also ran beaker immersion tests, to determine the effect of chelating agent solutions

on the metal components of the boxes. These tests showed that when used in a spray machine, a chelating agent solution could successfully remove metal contamination from the plastic boxes. These tests also showed that the chelating agent solution did not corrode or attack the metal components of the boxes. Based on these tests, I concluded that my concept of using a chelating agent solution in a spray machine, to clean metal off of plastic boxes, was valid.

9. I have read the Sugihara et al. U. S. Patent No. 5,705,089. Sugihara et al. discusses dipping a semiconductor substrate into a cleaning fluid containing a phosphonic acid chelating agent, to remove metals from the substrate (see Examples 1-19). This is a pure wafer immersion process. As described in paragraphs 4-7 above, at the time I was working on coming up with a metal removing apparatus, I rejected immersion processing, for the reasons given above.

10. In reading through Sugihara et al., I do not see any proposal or suggestion that the use of a chelating agent in general will aid in removing metal contaminants from a box. Because Sugihara et al. relates only to substrates or wafers, rather than plastic boxes, and because Sugihara et al. relates only to immersion, rather than spray, I see significant differences between the methods claimed in our patent application, and those described in Sugihara et al. In addition, due to the differences in materials, surface conditions, contamination characteristics, and size and shape, between wafers and boxes, there is no reason to believe that techniques used for cleaning wafers, as in Sugihara et al., could also successfully be used for cleaning boxes.

11. Sugihara et al. also uses a hydrogen peroxide cleaning fluid. See Sugihara Col. 1, line 24, 29, 49, 53, 66; Col. 2, line 16, 56, 67; Col. 3, line 5, 9, 18, 23; Col. 5, line 6, 9, 14, and the examples. Due to performance, cost, and environmental factors, in my research described above, I ruled out hydrogen peroxide, in favor of water.

I, Charles James Bryer, declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Charles James Bryer

Charles James Bryer

Dated: 1-28-2004